SCIENCE:

A WEEKLY RECORD OF SCIENTIFIC PROGRESS.

JOHN MICHELS, Editor.

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To Correspondents.

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DEPARTMENT OF AGRICULTURE.

At a time when the English Government appears to be awakening to the necessity of systematically bringing the light of science to bear on the various important agricultural problems which are continually forced upon public notice, it is an agreeable task to examine the reports of the Department of Agriculture at Washington, and to note the practical usefulness of the work there taken in hand, and the thoroughness with which it is performed.

The recent reports refer to one of the most important successes of this Department, that of obtaining crystalizable sugar from maize plants, which may be grown in most sections of the United States. Congress at once appreciated the value of this discovery and directed the Commissioner of Agriculture to furnish a report giving all the information in his power in regard to the manufacture of sugar from sorghum, its cost, the character and expense of the machinery necessary, together with statistics of the consumption and production of sugar in the United States and all matters bearing on the subject.

In the reply, which was made *seriatim*, we learn that the Department has thirty-two varieties of sugar producing sorghums and millet plants, all more or less valuable, according to the varying soils, climate, cultivation, seasons and process of manufacture. From these they have selected four, which in their opinion are best adapted to the ends in view. The most useful of these is the Minnesota Early Amber, the juice of which is said to granulate more readily than other varieties. It ripens early, yields bountifully an excellent quality of syrup, and the farmers who have raised this variety of cane record their experiences as showing it to be better than any other variety. The Department of Agriculture commends it for use in the Northern part of the United States in latitudes above Chicago.

Below this latitude the White Liberian Cane may be planted as auxiliary to the Early Amber, while in the latitudes of St. Louis and the region south of it, Honduras Cane should be added to the other two varieties, thus extending the season for working the cane many weeks beyond the period that could be utilized, if but one variety were planted. The Chinese Sorgo Cane ripens about two weeks after the Early Amber.

As the methods employed in making sugar from these plants have been already described, we need only add that experiments by the chemist of the Department during the last two years have demonstrated that there is practically little if any difference in the juice of the several varieties; that they all produce sugar which can be easily granulated, if the cane be taken at the proper season of growth, and that the only important question yet to be determined is as to the variety that will yield the largest amount in a given soil and climate.

We understand that only "*a fair measure of success*" has attended the manufacture of sugar, in the manner now under description, by farmers on a small scale, and we cannot too strongly endorse the sensible advice which has been tendered, that farmers should merely convert the juice of the stalks into a syrup, and that large central mills be established where the syrup may be converted by proper vacuum pans and centrifugals.

These central mills would have the same relation to this industry that the grist mills of a neighborhood bear to wheat and corn.

The making of sugar entails a process requiring considerable practice and experience, and we are not surprised to find that farmers find many difficulties in the way of success, and it will certainly pay them better to sell the syrup, to be converted under the direction of experts. We understand that in the Western States a gallon of dense syrup weighing, say 13 pounds, can be produced for 16⅔ cents (possibly less). This, if properly managed, should yield 6 to 8 pounds of sugar, and, if handled by the centrifugal, may be separated at a fraction of one cent per pound.

If this method of co-operation is carried out, we see no reason why the 2,000,000,000 pounds of sugar annually used in the United States should not be grown and manufactured within its boundaries and by native industry.

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HARVARD UNIVERSITY.

The following record of original work in progress at Harvard University, forms part of an interesting article by J. R. W. Hitchcock, A. B. :

In the last publication of the American Academy of Arts and Sciences, in which, by the way, seven of the eight papers are by Harvard investigators, appear the following "Propositions in Cosmical Physics," by Professor Benjamin Peirce :

1. All stellar light emanates from superheated gas. Hence the sun and stars are gaseous bodies.

2. Gaseous bodies, in the process of radiating light and heat, condense and become hotter throughout their mass.

3. It is probable that their surface would become colder if there were not an external supply of heat from the collision of meteors.

4. Large celestial bodies are constantly deriving superficial heat from the collision of meteors, till at length the surface becomes superheated gas, which constitution must finally extend through the mass.

5. Small celestial bodies are constantly cooling till they become invisible solid meteors.

6. The heat of space consists of two parts : first, that of radiation principally from the stars, which is small, except in the immediate vicinity of the stars ; the second portion is derived from the velocity with which the meteors strike the planet at which the observation is taken ; and this velocity partly depends upon the mass of the star by which the orbit of the planet is defined, and partly upon the mass of the planet itself.

7. If the planets were originally formed by the collision of meteors, it is difficult to account for an initial heat sufficient to liquefy them, and, at the same time, to account for their subsequent cooling without a great change in the number and nature of the meteors ; and any such hypothesis seems to invalidate the meteoric theory.

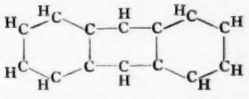
8. If the planets were not originally formed by the collision of meteors, their common direction of rotation becomes difficult of explanation.

Professor J. M. Peirce has recently published a set of "Mathematical Tables," in which the part relating to "Hyperbolic Functions" is entirely original. Other work in this department is represented by Professor Byerly's "Differential Calculus" and Mr. Wheeler's "Elementary Plane and Spherical Trigonometry."

The forbidding granite building called "Boylston Hall" conceals scenes of strange activity. Unwonted odors irritate the inexperienced nose of the visitor, and in the laboratories spectral shapes flit backward and forward behind clouds of vapor, occasionally lit up by lurid flames. These are the students ; but in their private laboratories the professors pursue their own researches. Professor Cooke has been dealing with that unprincipled element, antimony, which has obdurately persisted in claiming two atomic weights, until he has successfully limited it to one. In connection with his laboratory-work, Professor Cooke is preparing a new edition of his "Chemical Philosophy." The results of his inorganic work have appeared from time to time in the publications of the Academy of Arts and Sciences.

Since the "Organic Laboratory" was established, in 1875, Professors Hill and Jackson have published twenty-five papers giving the results of their work, and have discovered one hundred new compounds. The discovery of new compounds, however, possesses as a rule no special importance, and is rather incidental to, than the result of, the main work. Two examples will indicate somewhat the character and object of organic investigations. The *composition* of uric acid has been long known to be $C_5H_4N_4O_3$, but its *constitution*—the exact arrangement of the atoms—has been uncertain. Chemists all over the world had endeavored to settle the question, but their failures resulted in eleven different formulæ for this one substance. Professor Hill, taking this uric acid $C_5H_4N_4O_3$, marked one part by replacing H by CH_3 (methyl) ; then treating the acid so as to split it up, he determined to which part the methyl was attached, and, by continuing his treatment, was enabled to reduce the possible formulæ from eleven to three, with strong probabilities in favor of one. This possesses a practical value, inasmuch as it will lead to a knowledge of the method of formation of uric acid in the animal body. Professor Hill's work on "Fur ferrol," found in the products of the distillation of wood, is interesting, as chlorophyll can probably be obtained from it.

An example of the curious subtleties of science is afforded by Professor Jackson's investigations of anthracene, which is obtained from coal-tar, and yields alizarine (madder-dye), used in dyeing pink and purple calicoes, Turkey reds, etc. Anthracene was known to consist of two hexagons of carbon with hydrogen atoms attached, united by two other carbon-atoms. Professor Jackson proved, by making anthracene artificially, that these two carbon-atoms are united to adjacent corners in each hexagon, thus :



These are but stray examples of the researches that are constantly being made by Professors Hill, Jackson, and their assistants. Brom-benzylbromides, parachlorbenzyls, and benzaldehyds, however fascinating they may be to chemists, would offer few charms to the general reader.

Since 1841 Dr. Asa Gray has devoted such leisure as he could command to his great work "The Flora of North America," a labor the magnitude of which only an experienced botanist can appreciate. Mr. Watson, Curator of the Herbarium, is assisting Professor Gray, and at present is classifying the flora of California. The new series of botanical text-books, edited by Dr. Gray, will shortly be completed. The titles will be as follows :

1. "Structure and Morphological Botany of Phænogamous Plants," by Dr. Gray.
2. "Physiological Botany" (Vegetable Histology and Physiology), by Dr. Goodale.
3. "Introduction to Cryptogamous Botany," by Professor Farlow.
4. "Natural Orders of Phænogamous Plants and their Special Morphological Classification, Distribution, Products," by Dr. Gray.

One of the most recent of Dr. Gray's botanical contributions to the Academy of Arts and Sciences was a paper on the "Characters of some New Species of Compositæ in the Mexican Collection, made by C. C. Parry and Edward Palmer," and a notice of "Some New North American Genera, Species, etc."

Professor Farlow's work in cryptogamic botany is doubly interesting on account of its direct practical application. At the Bussey Institution Professor Farlow has been investigating the diseases of plants, and latterly has been engaged upon algæ and fungi. Among his recent work is a paper on algæ for the United States Fish Commission, an examination of the causes of onion-smut and the diseases of trees for the Board of Agriculture, and an investigation of the algæ producing disagreeable tastes and smells in water, for the State Board of Health. His work resolves itself, speaking generally, into two kinds—one, the abstract descriptions and arrangements in families of algæ and fungi, and the other the detection of fungi in disease. As an example of the first, there is a European species of alga which constitutes the green scum on stagnant water. Several different varieties may be found in different places, but they have all been discovered to belong to the same family. To illustrate the second, there is a certain kind of fungus on cedar trees, but this has been ascertained to be only a first stage, and the fungus in its second stage is found upon several members of the apple family.

Professor Wolcott Gibbs has been carrying on researches on complex inorganic acids, and Professors Lovering and Trowbridge have been conducting purely physical investigations. Professor Trowbridge has introduced a method of instruction that necessitates a large amount of original research on the part of his students. This consists of lectures, given by the students instead of by the instructor, to the class. Although all the work at the Observatory really comes under the head of original investigation, the observations constantly taken in connection with the Observatory Time Service resolve themselves into mere routine work. An immediate and practical benefit is conferred

by this Time Service, the signals of which reach Bangor, Lennoxville, in Canada, Albany, and New York, as well as different points in Massachusetts. The copper time-ball, held by a powerful electro-magnet at the top of the mast on the Equitable Life Assurance Building, Boston, is released at noon by the clock at Cambridge. During 1879 accidents caused a small error in its fall on two days only, and on three days it has been dropped at 12h. 5m. os.

The great equatorial of fifteen inches' aperture and the meridian circle whose telescope has an aperture of eight inches have been kept actively in use for the last three years. The former instrument has been devoted almost entirely to photometric work. The problem of astronomical photometry, roughly stated, is to determine the brightness of all the heavenly bodies, so that all may be compared with a single standard. Previous to the beginning of this work at the Harvard Observatory, photometric measurements had been made almost entirely upon the planets and brighter stars, and there was no definite knowledge of the amount of light emitted by the satellites and fainter stars. At the outset of the work several hundred measurements were taken of the brightness of the outer and inner satellites of Mars, which measures have been taken accurately nowhere else. The satellites of Jupiter and Saturn, including Hyperion, the faintest of Saturn's satellites, were similarly measured. In addition to measuring their brightness, a large number of determinations of the positions of the satellites were made. A comparison was also begun of the light of the sun and stars, with the idea of reducing all photometric measurements to a common standard—the light of the sun. This photometric work has been continued until the light of all the known satellites, except the two inner satellites of Uranus, has been measured.

One of the most important series of equatorial observations has been in connection with the eclipses of Jupiter's satellites. These phenomena have proved exceedingly valuable as a means not only of determining the orbits of the satellites themselves, but of measuring the distance of the sun or the velocity of light, and of obtaining terrestrial longitudes.

The observations of the mere appearance or disappearance of a satellite, however, can not be rendered sufficiently exact, and, to lessen the errors, photometric observations have been made of the satellites as they gradually enter or emerge from the shadow of Jupiter, using the planet itself or another satellite as a standard.

In order to furnish means for the comparison of the scales of stellar magnitude, employed by different astronomers in their estimate of the brightness of faint stars, a number of faint stars in the immediate neighborhood of the north pole were selected for photometric measurement, and a circular was distributed among astronomers requesting estimates of magnitudes of the same stars for comparison with such other, and with the results of the measurements made here. A series of measurements of all the planetary nebulæ has also been undertaken. This work with the great equatorial has necessitated the invention of a number of new photometric instruments, which have been devised by Professor Pickering and his assistants.

For nearly eight years Professor Rogers has been engaged upon one of the largest astronomical undertakings that has been successfully completed in this country. This is the observation with the meridian circle of the zone of eight thousand stars, between fifty and fifty-five degrees north, undertaken by this Observatory as its share in the determination of the position of the stars of the northern hemisphere. The observations were finished about a year ago, but some years will be required to complete the reduction and publication of this work.

The total number of observations for 1879 with the meridian circle, including about six hundred for the Coast Survey, was nearly three thousand. The scientists at the Observatory are now engaged in the task of determining the light of all the stars visible to the naked eye in the latitude of Cambridge. The meridian is used in observations like a transit instrument in connection with a new and elaborately designed photometer.

At the Museum of Comparative Zoology the staff of specialists is almost entirely occupied in the classification and arrangement of different collections and the publication of the results of their researches. The most important accessions during 1878 and 1879 are the extensive collections of the Blake dredging expedition, and the collections of birds, mammals, reptiles, and fishes, made by Mr. Garman at St. Kitts, Dominica, Grenada, Trinidad, St. Thomas, and Porto Rico, after he left the Blake. The Blake collections and specimens from the entomological, conchological, and ornithological departments are in the hands of well-known specialists for final investigation. Of the extensive work in progress it is impossible to give any details. The results are embodied in the extensive publications of the museum. Five volumes of bulletins have been published, averaging about a dozen papers each. The quarto publications will hereafter be issued as memoirs. The catalogues thus far published have been collected into Volumes I.–IV. of the memoirs. Five volumes of memoirs and the first part of the sixth have already appeared. The second part of the sixth and Vol. VII. are now in course of preparation or in press. Vol. VI. contains the great work upon which Professor Whitney is now engaged, "The Auriferous Gravels of the Sierra Nevada of California." The Sturgis Hooper Professorship of Geology, held by Professor Whitney, is noticeable as being founded solely for original research.

The dredging operations of the Coast Survey steamer Blake have not only aided zoological science by the information obtained in regard to echini, corals, crinoids, ophiurians, worms, hydroids, and others, but have added to geographical knowledge of the Caribbean Sea by showing the changes in form and distribution of lands along various groups of islands, and in the form of the land beneath the water. Professor Agassiz considers the deep-sea collections of the Blake the largest and most important ever made on this coast, and, when combined with the results of other expeditions sent out under the auspices of the Coast Survey, they make the collections at the museum but little inferior to those of the Challenger. During the coming summer Professor Agassiz will probably undertake another dredging trip in the Blake, following the course of the Gulf Stream to the north of the Bahamas, and dredging from the 100 to the 2,500 fathom line off the coast of the United States, so as to connect the isolated district with the deep-water fauna proper of the Atlantic.

Professor N. S. Shaler, Professor of Paleontology, in addition to his work at the museum, and as an instructor, has, since 1873, had charge of the Kentucky State Survey. Four volumes of reports and one of memoirs have been already completed, and one volume of memoirs and nine of reports are now in press. The recent writings of Professor Shaler are "The Origin and Nature of Intellectual Property," and several articles in the "Proceedings of the Boston Natural History Society," "The Atlantic Monthly," and "The International Review." The article by Professor Shaler in the latter magazine is entitled "Sleep and Dreams."

Scientific publications, based entirely or in part upon the entomological collection of the museum, are the new edition of the "Catalogue of the Diptera of the United States," by Osten-Sacken, published by the Smithsonian Institution, Part VIII. of the "Monographic Revision of the European Trichoptera," by R. McLachlan, published in London, and several papers by Dr. H. A. Hagen, the head of the department.

At the medical school the largest amount of original investigation is carried on in the physiological and chemical laboratories. In the former a number of new forms of apparatus are in use, which have been designed by Professor Bowditch and his assistants. Among these are an apparatus for keeping animals alive by artificial respiration; a dog-holder, canulæ for observations on the vocal cords of animals, without interfering with their natural respiration; unpolarizable electrodes used in studying certain problems in the physiology of the nervous system; a new form of apparatus for barometric measurements; and a novel plan for measuring the volume of air inspired and expelled in respiration. A new form of plethysmograph has been devised by Dr. Bowditch. This is an instrument for measuring the changes in the size of organs, either hollow or solid, which are produced by variations in the conditions to which they are subjected. The essential part of Dr. Bowditch's invention is a contrivance by which fluid is allowed to flow freely to and from the organ to be measured without changing its absolute level in the receptacle into

which it flows, while at the same time a record is made of the volume of the fluid thus displaced.

The more important work going on in the laboratory at the time of my visit consisted of experiments in regard to respiration, with special reference to the functions of the glottis and epiglottis, and trials of disinfectants with a view to ascertaining the temperature necessary to kill germs. A series of experiments was also in progress for testing the porosity of various stones used in building.

The results of the original work performed here have been recently published, together with an account of the physical apparatus in use at the school. Accounts of the most important investigations carried on during the last year are contained in the following papers: "Growth as a Function of Cells: Preliminary Notice of Certain Laws of Histological Differentiation," by C. G. Minot; "Effects of the Respiratory Movements on the Pulmonary Circulation," by H. P. Bowditch, M. D., and G. M. Garland, M. D.; "Pharyngeal Respiration," by G. M. Garland, M. D.; "Functions of the Epiglottis in Deglutition and Phonation," by G. L. Walton. This paper shows that the removal of the epiglottis does not seriously affect deglutition, and therefore it is not necessary for that process. The epiglottis, however, plays an important part in forming and modifying the voice, taking different positions during vocalization, changes of pitch, quality, and intensity.

In the chemical laboratory I found that Professor Wood had been examining the water-supply of Cambridge; and was then engaged in the investigation of the extent to which arsenic is being used in the manufacture or ornamentation of articles in general use, such as wall-paper, confectionery, playthings, etc. The results of this work will be published in the next report of the State Board of Health. Professor Wood is also writing the addition to "Ziemssen's Cyclopædia" on the subject of toxicology.

Dr. William B. Hills was engaged upon a special investigation in regard to the localization of arsenic in the animal economy.

The most important feature of original work at the school of late years has been Dr. Bigelow's introduction of the new operation of litholapaxy.

A number of interesting papers have been recently written by members of the faculty, some of which contain new discoveries of considerable scientific importance. I cite two: "Effects of Certain Drugs in increasing or diminishing Red Blood-Corpuscles," by Dr Cutter; and "Alterations in Spinal Cord in Hydrophobia," by Dr. Fitz.

The School of Agriculture and Horticulture, called "The Bussey Institution," is located on the sunny slopes of Forest Hills, about five miles southwest from Boston. The labors of the professors connected with this institution have been even more in the line of original research than of instruction, though of late the lack of a sufficient endowment has interfered with the quality of work and the publication of the results.

A number of exceedingly interesting and valuable papers, however, have appeared in the "Bussey Bulletin," the titles of which give some indication of the character of the work. I give a few of the more important: "Hybridiza- of Lilies," by Professor Parkman; "Diseases caused by Fungi"—Professor Farlow; Examinations of Fodders," "Trials of Fertilizers," "Prominence of Carbonate of Lime in Soil-Water," "Importance as Plant-Food of the Nitrogen in Vegetable Mold"—Professor F. H. Storer; "The Potato-Rot," and "The Black Knot" (of plum and cherry-trees)—Professor Farlow.—*Popular Science Monthly.*

ON THE EFFECTS PRODUCED BY MIXING WHITE WITH COLORED LIGHT.

It was noticed several years ago that when white light was mixed by the method of rotating discs with light of an ultramarine (artificial) hue, the result was not what one would naturally have expected, viz.: instead of obtaining a lighter or paler tint of violet-blue the color inclined decidedly toward violet, passing, when much white was added, into a pale violet hue. Two attempts have been made to account for this curious fact: Brücke supposes that the light which we call white is really to a considerable extent red, and that the mixture of this reddish white light with the blue causes it to change to violet. Aubert, on the other hand, following a suggestion of Helmholtz, reaches the conclusion that violet is really only a lighter shade of ultramarine-blue. He starts with the assumption that we obtain our idea of blue mixed with white from the sky, which, according to him, is of a greenish-blue color. We then apply, as he thinks, this idea to the case of a blue which is not greenish, namely, to ultramarine-blue, and are surprised to find that the result is different.

It will be shown in the present paper that these explanations are hardly correct, since they fail to account for the changes, which, according to my experiments, are produced in other colors by an admixture of white. I prepared a set of brilliantly colored circular discs which represented all the principal colors of the spectrum and also purple; these discs were then successively combined in various proportions with a white disc and the effects of rapid rotation noted, a smaller duplicate colored disc uncombined with white being used for comparison. Under these circumstances it was found that the addition of white produced the changes indicated in the following table:

Vermilion became somewhat purplish.
Orange became more red.
Yellow became more orange.
Greenish yellow was unchanged.
Yellowish green became more green.
Green became more blue-green.
Cyan-blue became less greenish, more bluish.
Cobalt-blue became more of a violet blue.
Ultramarine (artificial) became more violet.
Purple became less red, more violet.

Exactly these same effects can be produced by mixing violet with the above mentioned colors. These experiments serve to explain the singular circumstance that when complementary colors are produced by the aid of polarized light, it is difficult or impossible to obtain a red which is entirely free from a purplish hue, a quantity of white light being always necessarily mingled with the colored light. In the case of the red, orange, yellow, ultramarine, and purple discs, I succeeded in measuring the amount of violet light which different proportions of the white disc virtually added to the mixture, and found that it is not directly proportional to the amount of white light added, but increased in a slower ratio, which at present has not been accurately determined.

For the explanation of the above mentioned phenomena, Brücke's suggestion that white light contains a certain amount of un-neutralized red light is evidently inapplicable, since the effects are such as would be produced by adding a quantity not of red but of *violet* light, and for the present I am not disposed to assume that white light contains an excess of violet light. The explanation offered by Aubert does not undertake to account for the changes produced in colors other than ultramarine, and even in this case seems to me arbitrary; neither have I succeeded in framing any explanation in accordance with the theory of Young and Helmholtz which seems plausible.—PROF. O. N. ROOD, *American Journal of Science*

BERNARDINITE: ITS NATURE AND ORIGIN.

BY J. M. STILLMAN.

In a previous number of this Journal[1] I published the results of a chemical investigation of a resinous substance from San Bernardino, sent to me by Hon. B. B. Redding, which was said to occur in the form of vein in detached masses, and the vein to be traceable for three miles. The finders (farmers or "ranchers" of that vicinity) sent at the same time pieces of rock as vein-stuff which contained this peculiar resinous substance in the crevices. Some months later

[1] III, vol. xviii, p. 57.

another specimen was sent to this University from Santa Aña in the same section of the country by a resident who stated in his letter that on throwing a match upon the ground he was surprised to see these rocks take fire and burn. He therefore sent a piece to be examined.

The specimens furnished to Mr. Redding were examined by me and the result published in the above mentioned article. The substance, which was extremely light, white and porous, almost chalky, was shown to be mainly a well-marked resin, leaving but a trace of an ash on combustion. No theory was advanced as to its origin, and attention was called simply to its structure:—"On fracture it presents a slightly fibrous structure. Under the microscope it exhibits a two-fold structure—a quantity of very fine, irregular fibers permeating a mass of a brittle, amorphous, structureless substance." Since that paper was written I have endeavored to obtain more definite information as to the origin and occurrence of this peculiar substance. The region of its occurrence is so remote and so inaccessible that it has been impossible for me to investigate the matter in person, and difficult to find competent persons whose business takes them into that region. However, from reports obtained through the agency of Mr. Redding, I feel tolerably confident that the true nature and origin of this substance has been cleared up.

It seems that there grows, and probably has grown for a long time, a species of conifer which exudes large masses of a resinous secretion from abrasions or wounds. These resinous masses are reported to attain considerable size, and to fall off from their own weight. However that may be, the detached resin either from fallen and decayed trees, or from living trees, becomes scattered over the surface of the country and mixed with surface soil and rocks. By a long process of evaporation, action of atmosphere, and the leeching and bleaching agency of the snow which covers the ground for a large portion of the year, these resinous masses lose all vestiges of volatile and soluble matter, and at the same time a fungus growth permeates and splinters the whole mass into minute fragments rendered coherent by the fibers of the fungus. Hence the two fold structure noted, the fungus growth as shown in the previous paper, amounting to less than 10 per cent of the mass.

The perfect change which has taken place in the resin by these agencies evidence that the resin must have been exposed for an indefinite period to atmospheric agencies, and have attained a position of equilibrium toward its surrounding conditions. It is therefore apparently entirely a surface formation, which however has in process of time become so mixed in with surface soil and rocks as in some instances to present the appearance of being *in situ*. (*American Journal of Science.*)

UNIVERSITY OF CALIFORNIA, May, 1880

EDUCATION OF YOUNG ASTRONOMERS.

France has of late shown a greatly increased activity in astronomical work, both in the improvement of existing, and the institution of new, observatories. The question of how to provide these with men thoroughly competent to carry on the work has come prominently forward.

Hitherto, the recruiting of the observatories has taken place in the most irregular manner, and without the help of any special schools, such as are provided for other scientific careers. The candidates who have presented themselves have often neither possessed the theoretical knowledge, nor the ardor and special aptitude necessary for a career so difficult.

At the Paris Observatory, where the staff is the most numerous, and the *matériel* of instruments most complete, a certain amount of practical instruction could be given, but this only at the expense of the ordinary service, and through the goodwill of the older officials, whose regulations did not comprise this surplus work.

But in provincial observatories education has been more difficult, if not impossible. From lack of funds, it is unfortunately often the astronomical professor of the local faculty who is also director of the observatory, and he has to divide his time between these two functions. Sometimes, too, this director, an excellent professor of mathematics and celestial mechanics, has not been sufficiently initiated in the practice of the very delicate observations of astronomy requiring much experience and skill. Lastly, the *matériel* of these observatories has remained hitherto in a state of regretable inferiority, which could hardly inspire the observers with zeal. It will be readily understood, then, how the number of astronomical observers has been very limited, to the prejudice of astronomical work and discovery in France. This is the more regretted since that country has not been wanting in great geometers, who have remarkably promoted the arduous science of celestial mechanics; the illustrious names of Laplace and Leverrier will here readily occur.

It was, then, an urgent matter to form as soon as possible a superior school of practical astronomy, and with this view a ministerial decree has recently been promulgated. With candidates carefully selected and instructed for some time in a systematic way under masters of the science, a number of able astronomers may be looked for, competent to make a good use of the excellent instruments and opportunities that are now being plentifully provided.

The duration of the studies (to be carried on in Paris) will be two years. The first year will be chiefly devoted to the theoretical and practical study of the meridian service, the fundamental base of the astronomy of observation, and to the use of portable instruments, comprising those with reflection, for it is necessary that every astronomer in an observatory should be capable of teaching the use of instruments employed in traveling, and methods of observation, to the explorers, now so numerous, who, on leaving, seek preparatory instruction, the determination of latitudes and longitudes, &c., in the course of their travels. The second year will be devoted to service of equatorials and physical astronomy. The first half of each year will be occupied in lectures, studies, and exercises. During the second half, the students will make the regular service of observations along with the officials of the observatory.

The lectures will be as follows: During the first year, theory of the meridian service, by M. Loewy; practice of meridian observations, by M. Périgaud; calculations of spherical astronomy, by M. Gaillot; use of portable instruments, by M. Mouchez. During the second year, physical astronomy, equatorials, and physics of the globe, by M. Wolf; applied celestial mechanics, by M. Tisserand.

Moreover, MM. Jamin and Desains, the eminent professors of the Sorbonne, will open their physical laboratories to the young astronomers, and direct them in their studies and the management of instruments and various experiments which may interest them, and facilitate their labors in physical astronomy. M. Mascart, director of the central meteorological office, will also put them *au courant* with recent progress accomplished by meteorological science and service.

The work and lectures will be arranged so as to allow the students to attend other courses at the College of France and of the Sorbonne, having some direct relation to astronomy, or capable of being useful to them for obtaining university diplomas.

THE science of human life has been the last to recognize that minute interaction of all the sciences which every other department of knowledge now readily admits. We allow at once that no man can be a good physiologist unless he posesses a previous acquaintance with anatomy and chemistry. The chemist, in turn, must know something of physics, while the physicist cannot move a step until he calls in the mathematician to his aid. Astronomy long appeared to be an isolated study, requiring nothing more than geometrical or arithmetical skill; but spectrum analysis has lately shown us its intimate interdependence upon chemistry and experimental physics. Thus, the whole circle of the sciences has become a continuous chain of cycles and epicycles, rather than a simple sequence of unconnected and independent principles.—PROF. GRANT ALLEN, *Popular Science Monthly*.

ON A PHOTOGRAPH OF JUPITER'S SPECTRUM, SHOWING EVIDENCE OF INTRINSIC LIGHT FROM THAT PLANET.

By Professor Henry Draper, M. D.*

There has been for some years a discussion as to whether the planet Jupiter shone to any perceptible extent by his own intrinsic light, or whether the illumination was altogether derived from the sun. Some facts seem to point to the conclusion that it is not improbable that Jupiter is still hot enough to give out light, though perhaps only in a periodic or eruptive manner.

It is obvious that spectroscopic investigations may be usefully employed in the examination of this question, and I have incidentally, in the progress of an allied inquiry,[1] made a photograph which has sufficient interest to be submitted to the inspection of the Astronomical Society.

If the light of Jupiter be in large part the result of his own incandescence, it is certain that the spectrum must differ from that of the sun, unless the improbable hypothesis be advanced that the same elements, in the same proportions and under the same physical conditions, are present in both bodies. Most of the photographs I have made of the spectrum of Jupiter answer this question decidedly, and from their close resemblance to the spectrum of the sun indicate that, under the average circumstances of observation, almost all the light coming to the earth from Jupiter must be merely reflected light originating in the sun. For this reason I have used the spectrum of Jupiter as a reference on many of my stellar spectrum photographs.

But on one occasion, viz.: on September 27, 1879, a spectrum of Jupiter with a comparison spectrum of the moon was obtained which shows a different state of things. Fortunately, owing to the assiduous assistance of my wife, I have a good record of the circumstances under which this photograph was taken, and this will make it possible to connect the aspect of Jupiter at the time, with the spectrum photograph, though I did not examine Jupiter with any care through the telescope that night, and indeed did not have my attention attracted to this photograph till some time afterwards.

I send herewith to the Astronomical Society for examination the original negative which is just as it was produced, except that it has been cemented with Canada balsam to another piece of glass for protection. Attached to the photograph is an explanatory diagram, intended to point out the peculiarities which are of interest. It will be noticed at once that the main difference is not due to a change in the number or arrangement of the Fraunhofer lines, but rather to a variation in the strength of the background. In the case of the moon the background is uniform across the width of the spectrum in any region, but in the case of Jupiter the background is fainter in the middle of the width of the spectrum in the region above the line *h*, and stronger in the middle in the region below *h*, especially towards F. The observer must not be confused by the dark portion where the two spectra overlap along the middle of the combined photograph.

In order to interpret this photograph it must be understood that the spectrum of Jupiter was produced from an image of the planet thrown through the slit of the spectroscope, by a telescope of 183 inches focal length, the slit being placed approximately in the direction of a line joining the poles of the planet. The spectroscope did not, therefore, integrate the light of the whole disk, but analyzed a band at right angles to the equator and extending across the disk. If either absorption or production of light were taking place on that portion of Jupiter's surface there might be a modification in the intensity of the general background of the photographed spectrum.

A casual inspection will satisfy any one that such modifications in the intensity of the background are readily perceptible in the original negative. They seem to me to point out two things that are occurring: first, an absorption of solar light in the equatorial regions of the planet; and second, a production of intrinsic light at the same place. We can reconcile these apparently opposing statements by the hypothesis that the temperature of the incandescent substances producing light at the equatorial regions of Jupiter did not suffice for the emission of the more refrangible rays, and that there were present materials which absorbed those rays from the sunlight falling on the planet.

If the spectrum photograph exhibited only the absorption phenomenon above *h*, the interest attached to it would not be great because a physicist will readily admit from theoretical considerations that such might be the case owing to the colored belts of the planet. But the strengthening of the spectrum between *h* and F in the portions answering to the vicinity of the equatorial regions of Jupiter bears so directly on the problem of the physical condition of the planet as to incandescence that its importance cannot be overrated.

The circumstances under which this photograph was taken were as follows: Longitude of observatory $4^h\ 65^m\ 29^s{\cdot}7$ west of Greenwich. Night not very steady. Jupiter and the moon differed but little in altitude. Jupiter's spectrum was exposed to the photographic plate for fifty minutes, the moon was exposed for ten minutes. Jupiter was near the meridian. The photograph of Jupiter's spectrum was taken between $9^h\ 55^m$ and $10^h\ 45^m$, New York mean time, September 27, 1879.

I have suspected that perhaps there may have been an influence produced by the great colored patch on Jupiter which has made itself felt in this photograph. It may be that eruptions of heated gases and vapors of various composition, color, and intensity of incandescence are taking place on the great planet, and a spot which would not be especially conspicuous from its tint to the eye might readily modify the spectrum in the manner spoken of above.

SECULAR CHANGES IN THE EARTH'S FIGURE.

An interesting hypothesis has been promulgated before the French Academy by M. Faye. It has long been known from geodetic surveys and pendulum experiments that contingents and mountain ranges do not exert that attraction on the pendulum which might be expected of them, judging from the observed attraction of such isolated masses as Mount Schehallion, in Scotland, or the great pyramid. In fact, the deficiency of mountains in this respect is so striking that in order to account for it geologists and astronomers have imagined that there are vast cavities underlying continents and mountain chains. A somewhat different explanation of the feeble action of Himalayas on the pendulum has been offered by Sir George B. Airy, who supposes that the attraction of the mountains is counteracted by still fluid lakes of rock below them. But this suggestion does not meet the fact, elicited by M. Saigey, that the attraction on islands of the sea is greater than it ought to be. It appears to be clear, however, that there is a relative lack of matter under continents, and an excess of it under oceans. The hypothesis of M. Faye would seem to solve the problem in a very simple and reasonable manner. He holds that under the sea the earth's crust has cooled much more quickly than under dry land, and hence the solid sea-bed is denser and thicker than the sub-continental mass. Water is a good conductor of heat as compared with rock, and being liquid it is also able to convey heat from its underlying basin. Geodesy shows that the present figure of the earth is an ellipsoid of revolution; but if M. Faye's hypothesis be correct, it has not always been so. At first it was an ellipsoid, but the unequal cooling of the earth, due to the liquid mantle covering it, led to unequal stress and the elevation of continents where the crust was thinner. These continents, according to M. Faye, surrounded the north pole, and the level of the ocean over our hemisphere was raised, thus bringing the earth to a more spheroidal form. Finally, as the cooling continued, the austral continents attracted the oceans, and the figure became once more elipsoidal, as it is to-day. If this ingenious speculation were the true one, it would unquestionably help geologists to explain the origin of the glacial period.—*Engineering*.

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* Read before the Royal Astronomical Society, May 14, 1880.

[1] See paper "On Photographing the Spectra of the Stars and Planets," read before the National Academy of Sciences, Oct. 28, 1879, and published in this Journal, Dec., 1879, and in *Nature*, Nov. 27, 1879.

TRANSLATIONS.

M. Stroh presented to the *Société des Ingénieurs Telegraphistes de Londres* a very interesting memoir upon the measurement of the adhesion which occurs when a voltaic current of a certain intensity is made to pass between two metals of the same nature. The author of this remarkable paper has also devised a special instrument for the purpose of measuring the force necessary to separate the adherent metals. It is perhaps not inopportune to remark here that this adhesion should be considered as a disturbing force in many experiments, and especially in telegraphy. The measurement of the amount of force required to overcome the adhesion gave the following results expressed in grammes:

Copper	0.15	Zinc	11.	Platinum	42.
Silver	0.15	Tin	14.	Iron	85.
Alluminium	2.50	Gold	17.	Steel	100.
Bronze	8.50	Lead	18.	Tempered Steel	225

When contact takes place between two different metals, the force of adhesion appears to correspond with that of the metal requiring the least force for its separation. Thus the adhesion of tin with iron would require 14 grammes for separation, the corresponding figure for tin, and not that of iron, which is 85. The importance of this matter is quite obvious, and seems to be well worthy of complete investigation. On microscopical examination of the two surfaces placed in contact, M. Stroh finds that the adhesion always arises from the fusion of the superficial layer by the electrical current.—*L'Electricité.*

WATER JETS AS A SOURCE OF ELECTRICITY.

Mr. J. Elster, a pupil of the celebrated Professor Quincke, is about to present a thesis, at Leipzig, upon this interesting question. The following, according to the *Journal Philosophique*, are the conclusions to which this young *savant* has arrived:

If any electro-motor force whatever is produced by a jet of water, there must have been contact of the particles of the water with a solid body. This condition proves that the electro-motor force is produced by the friction of the particles of water with the metal, so that only a small portion of the liquid contributes to the production of electricity.

Furthermore, when the rapidity of the water jet is increased or diminished, the effect obtained is proportional to the active force of the particles of the liquid, and depends also upon the nature of the body placed in contact with the water.

This theory seems to be very similar to that by which Faraday explained the production of electricity in the Armstrong machine. The conclusions reached by the author are opposed to those of many *savants*, notably the Swedish electrician, Ed. Lund.

1. The movement of a liquid, of itself, cannot produce electro-motor force.
2. The currents called electro-capillary are in the same case whether the fluid moistens or does not moisten the walls of the tube. In the first case the friction takes place between the adherent portion of the liquid and the molecules in motion. In the second case, the molecules of the liquid rub distinctly against the sides of the tubes.

Finally, his conclusion is that the electro-capillary currents, which he claims were discovered by Professor Quincke, are identical with the currents developed by friction, which have been demonstrated by Zollner on the rubber of electrical machines.—*L'Electricité.*

A NEW ELECTRIC PILE.

M. Reynier has devised a hydro-electric pile, comparable in energy, to the nitric acid couple, without its inconveniences. The zinc is immersed in a solution of caustic soda. The porous cup is made of parchment paper. The new couple is about twice as strong as the ordinary Bunsen couple, and is surpassed only by the rectangular Bunsen couple (after the model of Ruhmkorff). M. Becquerel, Sr., has already used a similar pile.—*La Science pour Tous.*

THE METRIC SYSTEM.

To the Editor of Science.

In connection with Prof. Ward's able "Plea for the Metric System in Microscopy," in SCIENCE for July 31st, it may be well to state that the "American Metric Bureau," of Boston, 32 Hawley street, has for some years been advocating the general use of the system, not only by publication of "The Metric Primer," and of various circulars and bulletins, but in the very practical way of supplying standard metric articles at much less than ordinary prices. As Prof. Ward well says, "the way to introduce the metric system is to use it ourselves," and judging by the experience of the students in my laboratory, who are advised not even to name the antiquated weights and measures, a pocket or desk rule is a more convincing argument than exhortation.

BURT G. WILDER.

GENERAL NOTES.

THE transformation of alcoholic liquids into vinegar has long been a matter of discussion. Pasteur holds that the formation of vinegar is a physiological phenomenon caused by vegetation of a particular bacterium, the *Mycoderma aceti*, while Liebig sees in it merely a chemical action of oxygen on alcohol. Recent observations by Herr Wurm, at the Breslau Institute of Plant-Physiology, are regarded as putting the former view beyond a doubt, and Herr Wurm has succeeded in effecting the industrial manufacture of vinegar in accordance with Pasteur's idea.

MR. BISSINGER, M. E., at Carlsruhe, Germany, gives the following results as obtained in his examinations of the several motors in regard to their relative cost per horse-power for each hour. It will be observed that the examination pertained principally to small motors. The relative cost per effective horse-power per hour is as follows:

100	h.-p.	steam engine	7.6
2	"	"	44.3
2	"	Lehmann's caloric engine	26.5
2	"	Hock's motor	40.0
2	"	Otto gas engine	26.4
2	"	Otto Lang gas engine	26.4
2	"	Schmidt's hydraulic motor, supplied with water from the city waterworks	95.00
2	"	obtained by horses and a gin	45.00
2	"	obtained by manual labor	200.00

A CALCULATION of the height of the atmosphere has been recently made by Herr Ritter (*Wied. Ann.*), starting from this principle: The quantity of heat which must be communicated to a mass of air cooled to absolute zero to bring it, under constant pressure equal to the atmospheric, to the state of the lowest layer of the atmosphere, is the calorific equivalent of the mechanical work which would have to be expended to lift this same mass of air from the earth's surface to the limits of the atmosphere. Supposing, first, our atmosphere to consist of a gas which would retain the properties of a perfect gas to absolute zero, he gets the height 25km. Then, making the same calculation for an atmosphere of pure water-vapor, he gets 350km. Considering, lastly, that while it is not possible to make an exact calculation for real gases, which certainly condense and solidify like water-vapor before reaching absolute zero, one must obtain a result little different from that found in the case of such vapor, he concludes that the height of our atmosphere must differ little from 350km.—a number which agrees well with that deduced by Schiaparelli from observation of falling stars.

ACCORDING to some recent experiments of M. Goulier, the coefficient of expansion by heat of a metal is independent of any pressure put upon the metal, and is the same under a tensile strain as under one of compression.

SATURDAY, AUGUST 21, 1880.

ETHNOLOGY.*

FRAGMENTARY NOTES ON THE ESKIMO OF CUMBERLAND SOUND.

By Ludwig Kumlien.

The record of the voyage of the *Florence*, the vessel which conveyed the Howgate preliminary Polar expedition, has been printed by the Smithsonian Institution by request of Professor Spencer F. Baird, and forms the fifteenth of a series of papers intended to illustrate the collection of natural history and ethnology belonging to the United States, constituting the National Museum, placed in charge of the Smithsonian Institution by an act of Congress.

The report on "Ethnology" by Ludwig Kumlien is of great interest, and on this occasion we confine our attention to this part of the work, reserving other branches for future notice.

He states that the Cumberland Straits, Sound, Gulf or Inlet, extends from about lat. 65° N. to lat. 67° + N. It is the Cumberland Straits of Baffin, its original discoverer at the end of the sixteenth century; the Hogarth Sound of Captain Penny, who re-discovered it in 1839; and the Northumberland Inlet of Captain Wareham in 1841.

During the last quarter century it has often been visited by Scotch and American whalemen, ships frequently wintering on the southwestern shores.

It is at present unknown whether it be a sound or gulf; it is generally considered to be a gulf, but some Eskimo say that the Kingwah Fjord, one of the arms extending to the NE., opens into a large expanse of water, to them unknown. Icebergs are also sometimes found in this fjord which from their positions, seem to have come from the northward, and not from the south.

The eastern shore of this sound forms the western boundary of that portion of Cumberland Island which lies between its waters and Davis Straits, and known as the Penny Peninsula.

In about lat. 66° N. the Kingnite Fjord extends from the sound in a ENE. direction, and nearly joins Exeter Sound from Davis Straits; they are separated only by a portage of a few miles. The Cumberland Eskimo make frequent excursions to the eastern shore *via* these fjords, but seem to have extended their migrations but a short distance northward, finding Cumberland Sound more to their tastes.

The width of Cumberland Sound opposite Niantilic is about thirty miles, possibly its widest part. It is indented by numerous and large fjords, few, if any, of them having been explored; many islands are scattered along both shores, and in some instances form quite considerable groups.

The present Eskimo are few in numbers. We would estimate the entire population, men, women, and children, on both sides of the sound, from Cape Mercy on the east to Nugumeute on the west, not to exceed four hundred individuals. It is certain that within the last thirty years the mortality has been very great among them; even the whalemen remark an astonishing diminution in their numbers at the present day, as compared with twenty years ago.

Numerous traditions exist among them of the time when they warred with other tribes, and old men, now living, have pointed out to us islands that were once the scene of battles, where the besieged party was starved into submission by their enemies. According to the usual story, the hurling of stones was one of the most effective and common modes of warfare; this was especially the case when one party could get upon a ledge above the other. At the present day they are peaceful and quiet, have no recognized leader, and no desire to fight, even if their numbers would permit of it.

As the story goes, the present population were the victors in those fights, and took possession of the country they now inhabit. Some say they came from the northwest, and found another tribe, which they overcame and drove away. Their stories on this subject vary, and sometimes with this unusually interesting tradition, as well as many others, they get events of a very recent date hopelessly mixed up with the rest; and it is no unusual instance to find that some whaler, with a good imagination, has supplied and restored lost portions of the narrative, to their entire satisfaction; but these restorations are chiefly remarkable for their utter disregard of truth or possibility.

The following tradition is a translation from one of the most reliable natives we became acquainted with:

"A long time ago (*tichemaniadlo*) other Innuits (Eskimo) were found here; they were called 'Tunak'; they were very strong, very large, and had short legs and large arms; they had very wide chests. Their clothes were made of bear skins, and their knives from walrus tusks. They did not use bows and arrows, but only the harpoon-lance; they harpooned the reindeer in the water, from their kyacks, which were very large. The *Tunuks* made houses out of *stone*. They were able to lift large stones. We were afraid of them; we fought with them and killed them. They (the *Tunuks*) came in the first place from *Greenland*. The women made clothes from their own hair. They had no dogs at that time, but they made sledges and harnesses, and finally (*witchou* = by and by) put the harnesses on three rocks, one white, one red, and one black; they then called, and when they looked they found the stones had been transformed into dogs. After a time they got plenty of dogs; then they went about more. The present Eskimo could not understand their language. They lived to a great age (*E. tukewouk nami* = did not die!). Far to the west some Eskimo lately saw some *Tunuks;* they had bear-skin clothing. In the *Tunuks* land (where?) the *musk ox* (*oming muk*), bear, and seals are abundant. They build walls of stones on the land, and drive the reindeer into ponds, and catch them in kyacks. They have a large, long *callytong* (coat, or jumper jacket) that they fasten down around them on the ice while they are watching a seal's hole; underneath this garment, on the ice, they place a lamp; over this lamp they cook meat. Their eyes

* **Bulletin (15) of the U. S. National Museum. Contributed to the Natural History of Arctic America made in connection with the Howgate Polar expedition 1877-78. Washington: Government Printing Office. 1879.**

are sore all the time. We are afraid of them; do not like them; glad they have gone away."

This tradition differs somewhat in the particulars when told by different individuals, but the main points are essentially the same. Many will not tell it all; some, only parts of it. The ridiculous story about the dogs is firmly believed by the present Eskimo as the origin of these animals.

That the *Tunuk* have been seen of late years in the west is not improbable—that is, natives, different in dress and stature; but they were most likely the tribe known as the Pelly Bay Eskimo from the north shores of Hudson's Straits and from Fox Channel, they being larger and more robust than the Cumberland Eskimo of the present day. It is certain that since the whalers have begun coming among the Cumberland Eskimo, and introduced venereal diseases, they have deteriorated very much. They now almost depend upon ships coming, and as a consequence are becoming less expert hunters, and more careless in the construction of their habitations, which are merely rude temporary shelters made at a few minutes' notice. Great suffering often ensues from living in these miserable huts. The seal skin that should have gone to repair the tent is bartered to the whalemen for a little tobacco, or some valueless trinket, which is soon thrown aside. The men are employed to catch whales, when they should be hunting in order to supply the wants of their families; and the women, half clad, but sporting a gaudy calico gown, instead of their comfortable skin clothes, and dying of a quick consumption in consequence, when they should be repairing garments or preparing skins, are loafing around the ships, doing nothing for themselves or any one else.

The Cumberland Eskimo of to day, with his breech-loading rifle, steel knives, cotton jacket, and all the various trinkets he succeeds in procuring from the ships, is worse clad, lives poorer, and gets less to eat than did his forefathers, who had never seen or heard of a white man.

There is a practice among them that is probably of long standing, and is regularly carried out every season, of going into the interior or up some of the large fjords after reindeer. They generally go during the months of July and August, returning in September, to be on hand when the fall whaling begins. The purpose of this reindeer hunt is to procure skins for their winter clothing. Nearly all return to the sound to winter. They have regular settlements, which are hardly ever entirely deserted at any season. The principal ones are known as Nugumeute, Niantilic, Newboyant, Kemesuit, Annanactook, Oosooadluin, Ejujuajuin, Kikkerton. and Middliejuacktuack Islands, and Shaumeer, situate at different points on both sides of Cumberland Sound. During the winter they congregate at these points in little villages of snow-huts.

The present principal headquarters are at the Kikkerton Islands, or at Niantilie, according to which point the whalers winter. The old harbor of Kemasuit, once the winter harbor of whalers and a favorite resort of the Eskimo, is now deserted, except by a few superannuated couples, who manage to catch enough seal to live on.

As a rule, the present race is of short stature, the men from five feet three inches to five feet six. There are some exceptions, but they are in favor of a less rather than a greater height. The women are a little shorter. The lower extremities are rather short in proportion to the body, and bow-legs are almost the rule. This probably arises from the manner in which the children are carried in the mother's hood, as well as the early age at which they attempt to walk. The habit of sitting cross-legs may also have a tendency to produce this deformity. Their hands and feet are small and well formed. Their hands are almost covered with the scars of cuts and bruises. It seems that in healing the injured part rises, and is always afterwards disgustingly prominent. There is a great variation in the color of their skin, and a description that would answer for one might not apply at all to another. Even among those that are of pure breed there are some whose skins are no darker than a white man's would be if subjected to the rigors of wind and cold, and the never-removed accumulation of soot and grease. Others again seem to have been "born so." The children, when young, are quite fair. The eyes are small, oblique, and black or very dark brown. The hair is black, straight, coarse, and very abundant. It is rarely wavy or curly among the full-blooded Innuites.

There are, of course, exceptions to the above in case of half-breeds. Their faces are broad and flat, with rather large lips and prominent cheek-bones.

Infanticide is not practiced among the Cumberland Eskimo at the present day. I have learned from some of the most intelligent that this barbarous custom was in vogue in former times, however. Among the natives of Repulse Bay, and those living on the north shores of Hudson's Straits, it is practiced to a considerable extent, especially with the tribe known as the Pelly Bay natives. The practice is confined almost entirely to female children, the reason being, they tell us, that they are unable to hunt, and consequently of little account. It seems to have been referable to the same cause among the Cumberland Eskimo. Their intercourse with the whites seems to have modified some of the most barbarous of their primitive habits.

Twins are not common, and triplets very rare. The males outnumber the females. Infanticide may, to some extent, be the cause; but lung diseases, which are alarmingly prevalent, seem more fatal to the women than to the men.

Children are often mated by the parents while they are still mere infants. There is such an extreme laxity of morals that the young women almost invariably become wives only a short time before they are mothers.

It is impossible to say at what age the women cease to bear children, as they have no idea of their own age, and few are able to count above ten. Puberty takes place at an early age, possibly at fourteen with the female. They are not a prolific race, and it is seldom a woman has more than two or three children, and often only one, of her own; still many, or almost all, have children; but inquiry will generally divulge the fact that some of the children have been bought. Almost every young woman has or has had a child, but the identity of the father is in no wise necessary in

order to insure the respectability of the mother or child. Such children are generally traded or given away to some elderly couple as soon as they are old enough to leave the mother. The foster-parents take quite as good care of such adopted children as if they were their own.

So far as we could learn, they do not generally practice any rites or ceremonies of marriage. The best hunter, or the owner of the largest number of dogs and hunting-gear, will seldom have any difficulty in procuring the woman of his choice for a wife, even though she has a husband at the time. It is a common practice to trade wives for short periods or even permanently. They appear to have marriage rites sometimes, but we could induce no one to tell us, except one squaw, who agreed to, but only on condition that we became one of the interested parties and she the other. This was more than we had bargained for, and, although generally willing to be a martyr for the cause of science, we allowed this opportunity to pass without improving it.

Monogamy is at the present time the most prevalent. Polygamy is practiced only in the case of a man being able to provide for two or more wives. Three, and even four wives rarely belong to one man. Neither two nor three wives in one hut make an altogether harmonious household; but all little difficulties are generally settled by the husband, in a manner better calculated to insure reverence to masculine strength than respect for superior intelligence.

The scarcity of women at present in proportion to the men makes polygamy a luxury only to be indulged in by the wealthy. Divorce, if it can be called by that name, is very frequent among them. All that is needed is that the husband tires of his wife, or knows of a better one that he is able to procure. Neither does it seem to trouble the woman much; she is quite sure to have another offer before long; and a change of this kind seems to benefit both parties. One rather remarkable and very laudable practice among these people is the adoption of young children whose parents are dead, or, as often happens, whose mother is the only recognized parent. Orphans, so to speak, are thus twice as common as among civilized nations. These children, whether bought or received as a gift, are always taken as good care of as if they were their own, especially if they are boys.

Among the Eskimo employed by the Florence was a family that had two children, who passed for brother and sister. One, the boy, was a nephew of "Eskimo Joe," of Polaris fame. He had been brought from the Hudson's Straits Eskimo, some two hundred miles to the south. He was a perfect little satan; and, though he gave us much annoyance, he was a never-failing source of amusement to us all. The girl, again, was a native of Exeter Sound, on the west coast of Davis Straits; still, both were considered as their own children, and well cared for.

Half-breeds are said to be of more irritable temperaments, and less able to bear exposure and fatigue, than the full-blooded Eskimo.

The food of the Cumberland Eskimo consists entirely of flesh, and in most sections of the sound, *Pagomys fœtidus*. In fact, this animal is their principal dependence for food, fuel, clothing, and light. The Eskimo will eat a few of the berries of *Vaccinium uliginosum* and *Empetrum nigrum*, the roots of *Pedicularis*, and occasionally a little *Fucus vesiculosus* in winter, but this constitutes a very small and unimportant part of their food.

As soon as the ice has fairly left the sound, the Eskimo hunter leaves the winter encampment, with his family and such portions of his household goods as will be needed, and takes a tour inland or up some of the large fjords after reindeer. The larger part of his possessions, including sledge, dogs, harnesses, winter clothing, etc., he secretes among the rocks in some unfrequented spot. His dogs are put on some little rocky islet, to shift for themselves. They eke out a scanty subsistence by making good use of their time at low tide, *Cottus scorpius* constituting the greater part of their food at this season.

There are at present so many whaleboats owned by these Eskimo, that they experience little difficulty in making quite extensive cruises, three or four families constituting a boat's crew. They will load a whaleboat to within an inch or two of the gunwale, and then set out for a few weeks of enjoyment and abundance. The squaws do the rowing and the "captain" stands majestically in the stern with the steering oar, while the rest of the men are either asleep or on the lookout for game. The cargo consists of their tent-poles, the skin-tents, pots, and lamps, with sundry skin-bags containing the women's sewing and skinning utensils. Their hunting-gear, of course, forms a quite conspicuous portion of the contents of the boat. Very few there are at present who have not become the possessors of a half-barrel, and this vessel occupies a conspicuous place in the boat, and is almost constantly receiving additions of animal matter in some shape; a few young eiders or gulls will soon be covered up with the intestines of a seal and its flesh. From this receptacle all obtain a piece of meat whenever they feel hungry. This vessel is never emptied of its contents, except by accident or when scarcity of material forbids its repletion; and, as the temperature at this season is well up in the "sixties" during the day, this garbage heap becomes so offensive as to be unbearable to any one but an Eskimo.

They proceed at a very leisurely rate, rowing for a few minutes and then stopping for a time, chatting, smoking, or eating. When they feel tired they haul up on the rocks and have a sleep, and then resume the journey in the same vagabond manner. If, while thus cruising, any live creature that they think there is any possibility they can capture comes in sight, all hands become animated, the oars are plied with redoubled energy, guns and spears are in readiness, and every one is eager for the sport. Hours are often consumed in chasing a half-grown duck or a young loon which when procured is but a bite; but the fun of the chase seems to be the principal object, and they enjoy it hugely. Thus they journey till they reach some suitable locality, when the boat is unloaded, the toopiks raised, the lamps put in their places, and all is ready for a grand hunt. The men divide and scatter over the mountains, leaving the camp in charge of the women and children; these busy themselves by hunting for and destroying every living creature that they can find.

On the return of the hunters, who perchance have brought some skins and a hunk of venison, there are

joyous times in camp; the meat is disposed of first' and then the younger people engage in various games' while the older ones gather around some aged crone, who excitedly recounts the hunts of her girlhood days, plentifully intermixing stray portions of the old sagas and legends with which her memory is replete. Thus they live from day to day, the men hunting and the women stretching the skins, till the season comes around when they must return to the coast. Happy, contented, vagabond race! no thought of the morrow disturbs the tranquility of their minds.

When a deer is killed any distance from camp, the meat is cached, with the intention of returning after it in winter; but with what the wolves and foxes devour and what the Eskimo never can find again, very little is brought back.

Many have now firearms of some pattern or other; and though they will hunt for a ball that has missed its mark for half a day, they do not hesitate to fire at any useless creature that comes in their way. Those that have no guns use bows and arrows made from reindeer antlers. Sometimes the deer are driven into ponds, and even into the salt water, and captured in kyacks with harpoons.

(*Continued.*)

COAL.

By P. W. Sheafer, M. E., Pottsville, Pa.

I.

Coal is monarch of the modern industrial world, with its wonderfully diversified interests, and their ever expanding development. But supreme as is this more than kingly power at the present time, comparatively brief as has been the period of its supremacy, and unlimited, in the popular apprehension, as are its apparent resources, yet already can we calculate its approximate duration and predict the end of its all-powerful but beneficent reign. This is especially the case with our limited Anthracite; the more widely diffused bituminous having in reserve a much longer term of service—short indeed as a segment of the world's history, but so long, compared with an average human life, as to be of slight practical concern to the present generation.

The territory occupied by the anthracite coal fields of Pennsylvania is but a diminutive spot compared with the area of bituminous coal in Pennsylvania alone, to say nothing of its vast extent in other portions of the United States, and in Great Britain, France and Belgium. The area of the anthracite of the United States is but 470 square miles, not one-twentieth the size of Lake Erie, while the wide-spread bituminous coal fields cover twice the area of our four great lakes: the anthracite making but an insignificant showing on the map of the continent. But the comparison with the bituminous area is deceptive, unless the relative thickness of the two is taken into consideration. If the anthracite beds were spread out as thinly as those of the bituminous region they would cover eight times their present area, or 3,780 square miles. And, again, if the denuded spaces within the borders of the anthracite coal fields were covered with a deposit of coal as thick as we may justly suppose they once were, and as the remaining still are, the available area would be increased to about 2,000 square miles, or 1,280,000 acres; equal to a coal deposit of 92,840,960,000 tons.

Contemplating the number and extent of the coal beds, a total thickness of 107 feet, distributed in fifteen workable beds, interstratified with a full mile in thickness of rock and shale, we are lost in wonder at the luxuriant growth of tropical plants required to produce this vast amount of compressed fuel, and the mighty processes of nature by which it was placed in its present position. The ingenuity of scientists is taxed to account for this wonderful accumulation of fuel, once vegetable, now mineral; once waving in fresh green beauty on the surface of the earth, now buried under hundreds of feet of solid rock; once growing in a level deposit of mud so plastic that the lightest leaflet dropping on its surface, left its impress; now the mud hardened into slate, and the rank vegetation changed to hard and glittering coal, rising and falling in geologic hills and valleys, surpassing in number, depth, extent, sharpness of flexure and acuteness of angle, anything visible in the light of upper day.

Some slight idea of the growth of these ancient forests may be gained from the computation that to form only one of these large beds of coal required a deposit of vegetable matter perhaps one hundred feet in thickness. What shall we say then to the amount of vegetation stored away in the mammoth bed which extends through all three of the anthracite coal fields, covering an area of 300 square miles, with an average thickness of twenty feet, and containing, it is estimated, 6,000,000,000 tons of coal.

Not less wonderful and interesting than the coal deposits is the grand floor of conglomerate which underlies them; a vast sheet of rock, infinitely old, composed of fragments of other rocks infinitely older, bound together by an almost imperceptible cement which holds them so firmly that gunpowder will scarcely separate them. Whence came this great sea of pebbles, water rounded and water-borne to their present resting place? We find them now as the current has dropped them—masses of silex as large as ten-pound cannon balls, and almost as round, so shapely have they been worn by the action of some ancient current. These were deposited first, and then, in regular order, trending to the southwest, came sizes graduated down to those of a pea and grains of sand.

This more than marble floor bears few saurian foot prints; scarcely an impress of bird or beast or fish, or sign of animal life. Nothing but a bed of almost pure silica; a solid foundation on which to build up the mass of rock and the fossil fuel that we call anthracite, older than the hills and predestined for the use of coming man.

The pebble-laden flood ceased, and was followed by placid waters and gentle currents, bringing fine mud and silt to cover the rocky bed. Then the waters drained away, or the land rose, until fit for vegetable life, it was covered with the mighty flora of the car-

boniferous period. Again it sank, carrying with it its store of decayed and decaying vegetation, and another flood of pebbles rolled over it.

How many ages were consumed in the process so briefly described, who can tell? Nature's operations are on too vast a scale, and her working time too long to admit of hasty activity in the production of results. It may well be said that all the years since the creation of man would be too short a time to produce a bed of coal.

However long the process just described, it was of frequent repetition during the coal period; and thus we find pebble-beds, slate and coal in often recurring series, as in the following cross-section made at Trevorton, the western terminus of the middle Anthracite coal basin.

But through all the changes of time and scene, the upheavals and depressions, the submergence and emergence of the land, we find a remarkable uniforformity in the growth of plants, continuing almost without change throughout; sigillaria, lepidodendra, ferns, etc., following their kind, unvaried through successive series of strata, in each leaving their characteristic impress of stems and foliage on the enduring tables of the rocks. The coal flora is rich in variety and of great beauty, as Professor Lesquereaux's careful research abundantly testifies. Their exact forms show a quiet condition of the waters, at least during the deposit of the slate covering of the coal beds; and the intervening rocks show the same facts. When impressions of the flora are found in the solid coal itself, we have the same evidence; but this is of rare occurrence. The best impressions usually occur in the smooth top slate covering the coal beds.

When we examine the arrangement of the Pennsylvania Anthracite beds we wonder at their complexity. Without evidence of volcanic disruption, not even a protruded trap-dyke, or extensive up or down throw, we often find contortions and disturbances of the strata. The beds are rarely horizontal, but lie at every angle, and sometimes even pass the perpendicular and fold back upon themselves. In places they occupy our mountain summits, nearly 2,000 feet above the level of the sea, and again depressed more than 3,000 feet below it, making a variation of a mile in altitude. Yet the coal, which is the frailest material in all this rocky mass, is not destroyed, but generally in good workable condition—solid, almost crystalized, almost pure carbon, and frequently in beds too thick for economical working.

Faults in the Anthracite beds usually have a northwest and southeast direction, and show the beds compressed, and again correspondingly enlarged, but no sudden dislocations or breaking off of the strata. Soft coal, or dirt faults, are of common occurrence in the red ash or softer coals in the western end of the Anthracite fields.

The colored ash of burned coal is due, doubtless, to the presence of iron; but why this coloring matter is confined to the upper series of coals in the eastern portion of the range, and to the lower beds in the western district; and why there is a gradation in the middle district, from white ash in the lower to grey in the middle and red in the upper beds, are problems yet to be solved.

How shall we account for the great disturbance of the strata from their original horizontal position? Was it caused by volcanic force—of which there are no indications—or by contraction of the earth's crust? And if the latter, why is it confined to the Anthracite region, and not extended to the Bituminous also? And how shall we explain the isolation of the smaller coal fields, like those of Rhode Island, Richmond, Va., or Deep River, in North Carolina; or the disproportion in quantity between the limited area of Anthracite and the widespread fields of Bituminous? Why do we find an abundance of shells and remains of animal life in the latter, and rarely any in the former? A few saurian footprints recently found at the Ellangowan Colliery, in Schuylkill County, and a few shells found in the Glendower Pit, in the Wyoming Valley, are signal exceptions to an almost universal rule. After an exploration, covering the period from 1835 to 1850, Prof. H. D. Rogers and his corps of assistants failed to find any other specimens. Neither has Prof. Lesley in his new Geological Survey of Pennsylvania, or the writer in an experience of thirty years' residence and active service, underground and in surface explorations, been any more fortunate.

Nor in all this area do we find a single workable bed of iron or limestone, and scarcely a covering of fertile soil. The coal once exhausted, nothing is left but the worthless shell, desolate and deserted.

The Anthracite region, mainly confined to one-sixth the area of the four mountainous counties of Luzerne, Schuylkill, Carbon and Northumberland, in Pennsylvania, is crowded with an industrious population which increased fifty-one per cent in ten years; that is, from 229,700 in 1860 to 344,771 in 1870; whilst the four adjacent agricultural counties of similar area increased in the same time from 319,542 to 339,942, only six per cent. It is located on the parallel of 40° 30', one hundred miles from any seashore, no part of it less than 500 feet above tide—near the headwaters of the large rivers that drain it—the Susquehanna, Schuylkill, Lehigh and Delaware. The noisy trains crossing the valleys and climbing the mountains all verge, day and night, to these hives of industry, where multitudinous steam engines are hoisting and pumping, and breakers crushing. Thousands of miles of railroad thread the surface and dive into the interior, to roll out the black diamond flood in millions of tons of fuel to warm and employ the nation.

In a second paper, I propose to offer some important statistics and information regarding the harvesting of coal.

As a supplement to articles in the last November and January numbers of the *American Journal of Science*, John M. Stockwell details his investigations into the general theory of the moon's motion as affected by the sun's attraction. While taking a rather despondent view of our present knowledge of the factors in lunar calculation, he admits that the general methods of computation are undoubtedly correct.

J. M. Stillman, in August *Journal of Science*, describes the appearance of a new resinous substance in a rocky matrix, from San Barnadino, Cal. It is found in detached masses, in vein form, over a distance of three miles. He seeks to explain its existence by ascribing it to exudations from existing conifers, but does not account for its paragenesis.